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ABSTRACT
        The introduction to this selective bibliography on
the use of computers in teaching statistics provides a brief review
of the role of the computer in statistics: the role of statistical
packages: how statistical packages should be used in instruction:
science, statistics, and data analysis: and choice and evaluation of
statistical packages. Items listed in the bibliography are concerned
both with instructional applications of computers and with the
evaluation and comparison of statistical software. A copy of a
questionnaire seeking information on available statistical software
is appended, together with selected responses. These questionnaires
were used to compile the data reported in the Index of Publicly
Available Statistical Software, by Kohm, Ryan, and Velleman (1977).
(LLS)

GUIDELINES TO THE USE OF COMPUTERS

IN STATISTICAL INSTRUCTION

Robert F. Ling[*]

ABSTRACT.   In th   document   the author provides
with an out.   ias information, as well as sources   d
references   et information, on topics d
ted to the use of   ers   statistical instruction

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1. INTRODUCTIO

The use of the computer for statistical analyses has been growing by leaps and bounds in the past decade. Some indirect evidence of this rapid growth are: the increased proportion of articles reporting computer based results in statistical journals; the large number of publicly available statistical software and packages (reported by Francis, Ryan, and Velleman (1977), e.g.) many of which became available only within the past five years; the creation of a Section on Statistical Computing within the American Statistical Association; the initiation of Users Groups, Newsletters, special meetings, etc. associated with particular statistical packages such as SAS and SPSS, as well as increasing numbers of short courses, workshops, tutorials, and the like for various packages; and so on.

The use of the computer and statistical packages for statistical instruction, on the other hand, has been growing at a much slower pace, in comparison with other usage, whether measured in quantity or in quality. Systematic and regular use of the computer in teaching statistics is far from being universal, and may still be considered to be the exception rather than the rule, at all levels of instruction. There are many reasons for the apparent slow growth in computer-assisted instruction in statistics. Two of the main ones are. (1) many instructors of statistics, who are knowledgeable in the subject and its traditional methods of instruction, are unfamiliar with, or ill-at-ease in, the use of the computer in general (or the particulars in the use of statistical packages) or the effective use of such facilities to assist the instruction of statistical topics. Consequently, text material and lecture notes that are independent of the computer and recent advances in its software are still widely used. (2) Of those instructors who are knowledgeable in statistical computing, the following type of sentiment is often expressed, "it is sufficiently difficult to cover the statistical material in a course without having to teach the students computing (such statements are often accompanied by laments about the students' lack of background or interest in mathematics, statistics, or computing, it would be impossible to teach them the use of statistical packages (or the computer) and still have time left to teach them statistics."

Both the above reasons can be attributed to the same cause, to a large extent. This cause might be termed "unfriendly computerese". It is quite apparent that difficult-to-learn or unnatural languages associated with operating systems and statistical packages have been deterrents to statistical computing for many instructors and students who otherwise would have made considerably more use

of them. Fortunately, the situation is steadily improving: package developers are generally paying more attention to the userinterface aspects of their products; user manuals are better written; and there are recently developed systems such as IDA and Minitab which are particularly suitable for use in conjunction with statistical instruction because of the simplicity of the languages.

In this article, the author provides the reader with an outline of basic information, as well as sources and references for further information, on topics directly related to the use of computers for statistical instruction. We believe such information will be useful to those who are contemplating the introduction of statistical packages as an aid to their teaching. Some of the information should be useful even to those who are already using the computer in their statistical instruction because they may not be aware of much of the existing resources and literature references assembled here.

2. THE ROLE OF THE COMPUTER IN STATISTICS

The computer is playing a major role today in various aspects of research, application, and instruction in statistics. In view of the tremendous power of existing computers and the availability of high quality software, statisticians not only can perform traditional computing tasks (associated with well established methodology) with utmost ease accompanied by a high degree of numerical precision, but can also approach old problems from new points of view much of which would not have been possible without the computer to perform the otherwise extremely tedious computations. Among the major areas of statistical applications in which the computer is an indispensible tool are:

A.--Monte Ca .. St es and Simulation Experiments,

B.--Routine Statistical Analysis of Large Datasets,

C.--New Methodologies Involving Large Amounts of Computing, e.g., Robust Methods, Iterative Methods, and Subsampling Methods,

D.--Exploratory Data Analysis and Model Building,

E.--Validation of Statistical Assumptions via Residuals Analyses and Graphical Methods.

3. THE ROLE CF STATISTICAL PACKAGES

Current usage of statistical packages, whether measured by the number of people engaged in those activities or the amount of computer time used, probably falls within the following categories listed in decreasing crder of usage:

A.--Descriptive and Tabular Analysis. Tools for users in their preparation of of reports involving tabular and graphical displays cf data or summaries of data.

B.--Tools' for statisticians to facilitate the performance of tasks in 2. A-E.

C.--Aids to teachers in the instruction of statistics.

4. HOW STATISTICAL PACKAGES SHOULD BE USED IN INSTRUCTICN

We first propose some general guidelines on the use of statistical packages in instruction, independent of how they are used to convey specific statistical concepts or to illustrate specific methodologies. They are as follows:

A.--Packages should simply be used as a tool in the proper analysis of statistical data. A proper analysis must nct te ccnstrained by what a particular package can or cannot do. Often an analysis may require the use of several different packages because of the limitations of capabilities in the "standard" packages. Sometimes, none of the existing packages will deliver what needs to be done on a particular prcblem, in which case special programs or routines must te written to perform the necessary tasks.

B.--The roles of statistics, statistical packages, and their interface should be clearly established. It is the duty of the instructor to convey tc the students the prcper ccncepts of statistics and the proper application of statistical methodology, regardless of what statistical packages are available, what procedures are available within a particular package, cr what sorts of outputs are available within a particular procedure of a particular package.

Statistical packages (or the instruction of

material and the packages themselves) should play
a supporting role to the learning and application
of statistics. Far too often, students and
instructors alike get too involved with the
mechanical aspects of various software packages
that they may acquire the skills to use one of
"the packages" to run jobs using statistical
software, while they lack the skills to interpret
the results properly or to know the appropriate
strategy that should follow in analyzing
problems of this.

These concepts of statistics can often be
illustrated by simple numerical examples run on
statistical packages. Such demonstrations never
"prove" anything but they invariably give the
students a much better grasp of the theoretical
concepts if have seen one or more numerical
demonstrations of those concepts. The fundamental
ideas underlying a sampling distribution, a
confidence interval, the central limit theorem, and
many other difficult theorems can easily and
convincingly be illustrated by numerical examples
using statistical packages.

It is very difficult, if not impossible, to set forth a
set of guidelines on how to teach specific topics of
statistics using the computer. To teach any particular
topic, the instructional material which is optimal for an
elementary level course will not be suitable for an audience
in an intermediate or advanced course. Hence, even if the
same statistical package is used to aid the instruction of
the same topic, much care must be given to how the
computational results are to be presented or used by
different classes of students (at various levels. There
does not appear to be any sound, general rules, nor any
concentrated source of good examples. In subsection A of
the reference section, a number of recent articles are
cited. These articles deal with the actual use of the
computer or statistical packages at various levels of
instruction, on a large number of topics. The list of
articles is only intended to serve as a representative
sample recent work on computer-based methods or material
in statistical instruction. Moreover, since many
statistical packages are being used in instruction, only
those articles about "the use of package X in teaching" are
cited. Articles about "package X" or about statistical
packages 'but without an emphasis on their use for
instruction are purposely omitted in order to keep the list
moderately small. While the computer and statistical
packages are used to facilitate computational tasks
association with the execution of statistical methodology,
one important aspect of statistics -- its underlying
philosophy -- and the impact of the computer on the

realization of the phil=sophy, is ofte= overlcoked i=
instruction, especially .= elementary sta=istical courses
We shall briefly discuss =hat philosophy ±nd approach in th=
next section.

=. =C=NCE, STA=======S, AND DA=. ANALYSIS

Trac =io=a= textbook= o= statistics and conventiona=
methods c= ==========ion of==n ==1 short c= the real goals o=
statistic   ==== of prot_e= =lving an= analysis of rea=
data. =========: problems ==e ==ten presen+ed in the form o=
clear-cu=   =11-defined e====ses in confirmatory analysi=
that bea=   ==e resemblanc= = the problems one is likel=
to encou== == the Real Wor=d.

St====== ==l analysis i= a delicate blend cf art and
science   =lyzing statisti==l data is seldom, if ever, a
one-pas= =f= =. In addit=== tc rcutine examination and
display =f =s data for   ==rical =ccuracy, edit and
transfo== = =ecessary, = statisticiar usually has to
carry   =: = analysis th=   = several iterations before
arrivi= =t =me tentative =nclusicns. The use of the
compute =n = =struction gre= =y facilitates the teaching of
the rea=_=tic and proper = =cach tc statistics. Such a
philosc=-=7 =d approach i= =rticulated in the following
excerpt=

"=== =a=lysis, and =he parts of statistics which
adhere = it, must then take cn the characteristics of a
science ==the= than those cf mathematics, specificallv:

(1) Data analysis must seek for scope and
    usef lness rather than security.
(2) Data analysis must be willirg to err
    moderately often in order that inadequate
    evidence shall more often suggest the right
    answer.
(3) Data analysis must use mathematical argument
    and mathematical results as bases for
    judgment rather than as basis for proof or
    stamps or validity." (p. 6)

"If data analysis is to be well done, much of it must
be a matter of judgment, and 'thecry', whether statistical
or non-statistical, will have tc guide, nct command."(p. 10)

"The most important maxim for data analysis to heed,
and one which many statisticiars seem to have shunned, is
this: Far better an approximate answer to the right
question, which is often vague, than an exact answer to the

wrong question, which can always be made precise. (p. 13)

JOHN TUKEY (1963) "The Future of Data Analysis" in
Annals of Mathematical Statistics.

What Tukey said fifteen years ago remains timely today
because exploratory data analysis entails considerably more
computation, through trials and refinements, than its one-
pass confirmatory analysis counterpart. Such an approach is
possible, but impractical, without the support of
appropriate computing software. Box(1976) reiterated the
same theme in a recent article in which he said

"In the inferential stage, the analyst acts as a
sponsor of the model. Conditional on the assumption of its
truth he selects the best statistical procedure for analysis
of the data. Having completed the analysis, however, he
must switch his role from sponsor to critic. Conditional
now on the contrary assumption that the model may be
seriously faulty in one or more suspected or unsuspected
ways he applies appropriate diagnostic checks involving
various kinds of residual analysis." (p. 793)

"The symptoms of (cookbookery) are a tendency to force
all problems into the molds of one or two routine
techniques, insufficient thought being given to the real
objectives of the investigation or to the relevance of the
assumptions implied by the imposed methods." (p. 797)

"Mathematistry is characterized by development of
theory for theory's sake, which since it seldom touches down
with practice, has a tendency to redefine the problem rather
than solve it." (p. 797)

GEORGE BOX (1976) "Science and Statistics" in
Journal of the American Statistical Association.

The iterative process of being a sponsor and a critic
of various tentative models is most effectively carried out
with the aid of appropriate interactive statistical packages
or languages. The reason is that although the same steps of
analysis can be carried out using packages run in the batch-
mode, the long waits in turnaround between job submission
and completion generally inhabit (at least deter) the
statistician or the student from trying out a large number
of small changes in the analysis or exploring as many
alternative modes of analysis as they would under an
interactive enviroment.

The interactive system IDA was created at a time and

enviroment when : 6 hours turnaround for batch jobs was not uncommon, i er that exploratory analyses could be carried out in c cticn with a ccurse in data analysis without the frus ons of long delays associated with batch computing. nce its creation in 1972, it has not cnly been used :mvily and effectively as an aid to statistical instruction, but has also been a useful tool in many projects of serious research and real problem solving. Ling and Roberts (1975) describes the interface between interactive computing and data analysis as follows:

"Interactive computing articulates extremely well with the requirements of enlightened statistical analysis, in which the analyst examines data to help formulate an appropriate statistical model, applies diagnostic checks to criticize the model, revises the model as necessary, and continues the process until he is satisfied with that he has done about as well as he can within the given constraints of time and space. Only then does the final statistical analysis ensue, and that is relatively cut and dried." (p. 411)

"Unlike many textbook descriptions of statistical analysis, and also unlike many statistical packages (even in timesharing), IDA does nct presume that an analysis need be done in a fixed sequence of operations. In order to rxploit the capababilities of user-machine iteration, IDA breaks down statistical operaticns intc relatively small modules that can be executed in any sequence that is logically possible. This permits the user to take advantage of what he has learned at each stage before deciding what to do next. Except for certain obvicus restricticns in the order of execution of commands (for example, the user must first enter his data before he can edit, displar, or operate on it), the user has complete freedom in going from any one command to any other. Such freedom is particularly important and useful in exploratory data analysis for regression, where, in the prccess cf deciding on a model that does justice to what seems to be happening in the data, the user generally needs tc examine residuals and fitted values for tentative models, try transformations, possibly delete observations to cbtain insight intc the effect of outliers, and examine various plots and numerical model-adequacy checks, not in any specific order but in an order that appears appropriate for the problem at hand, depending on the feedback and interpretaticn of intermediate results. Such a mode of analysis, though possible under other systems, is generally much more cumbersome to execute than in IDA." (p. 415)

ROBERT LING AND HARRY ROBERTS (1975) "IDA: An Approach to Interactive Data Analysis in Teaching and Research" in *Journal of Business*.

6. CHOICE AND EVALUATION OF STATISTICAL PACKAGES

A useful and up-to-date reference on the publicly available statistical software packages is the Index of Statistical Software, edited by Robert F. Kohm, Thomas A. Ryan, Jr., and Paul F. Velleman; available in microfiche form in the Proceedings of the Statistical Computing Section, American Statistical Association (1977). It consists of a compilation of the responses by 56 package developers regarding the capability, availability, portability, cost, and other relevant information about each package. In addition, abstracts of the packages (written by their developers) are provided.

Kolm, Ryan, and Velleman describe the purpose and content of the Index as follows:

"The purpose of the index is to provide a single reference capable of answering many of the first questions that may arise when an individual is trying to determine which computer program might best serve his needs. To serve this goal, the index consists primarily of three parts. Part 1 is a listing of the general capabilities of the indexed programs. The goal of this portion of the index is to cross reference programs and capabilities, e.g., which programs do ANOVA, Simple Data Descriptions, Factor Analysis, etc. The second part of the index consists of miscellaneous details about each program. This portion of the index is designed to aid the reader in determining whether the programs of interest to a particular user will run on his machine, in what computer language it is written, in what form is the program available, etc. The third portion of the index consists of the names and addresses of the developer, distributor of the program, distributor of the documentation, and the person who completed the questionnaire reply. It also contains an abstract of the computer program written by the person who completed the questionnaire, typically the developer. Virtually no guidelines were given to the developer in the writing of the abstract, so they are quite different in appearance. The abstracts provide the developers with a form in which they may describe special features of their program that are not adequately covered by the questionnaire. Many developers have chosen to describe their strong points and those features which they feel make their programs unique."

The author believes the Index will serve its goals well and that the Index (and its future editions) will prove to be an indispensible source of information about the available statistical software. The questionnaire which generated the Index is reproduced in Appendix A, and the tabulation of the responses is reproduced in Appendix B.

The Index makes no attempt to evaluate any of the
indexed packages. There are many recent articles which deal
with the evaluation and comparison of packages or particular
routines within packages. A list cf such articles is given
in subsection B of the Reference section.

In choosing one cr more statistical packages for
instructional purposes, care should be given to the "ease of
use", "handiness", or "friendliness" of the packages. A
package which has a complicated control language or data
structure will necessitate students spending much time
learning to use the package itself, thus leaving much less
time learning about statistics. Existing packages leave
much to be desired in their user-interface implementations.
"Unfriendly" systems and packages still abcund, and they
should be avoided as instructional aid in statistics,
especially in courses taught at an elementary level. Many
universities find it necessary tc cffer special 1-credit
hour courses just to teach students the control language of
one statistical package, such as SAS (which is one of the
more "friendly" packages). The fear and frustration
students may experience in using less "friendly" packages
can be extrapolated from that.

7. OTHER SCUECES OF INFORMATION

Apart from journal articles, meetings, and other
activities affiliated with scientific societies, there are
numerous special publications and special crganizations that
provide services and information that are pertinent to the
use of the computer in statistical instruction. Some of
these are described below:

A. Information cn hcw ccmputers are used for
instructional purposes (not limited to statistical
instruction) by 57 educational institutions ranging in
level from elementary schools to major universities has been
compiled by the Human Resources Research Organizaticn,
published as the Academic Computing Directory (1978). The
Director, not only identifies the "exemplary" institutions,
but provides information cn the computers they have, how
they are used, and the reasons the institutions were
selected as "exemplar" of academic computing. In addition,
the name and address of a ccntact person at each institution
- one who will answer questions from inquirers - is provided
for each entry. Copies of the Directory are available for
$3.95 each frcm:

Human Resources Research Organization
300 N. WashingTon Street
Alexandria, VA 22314

B.   EDUNET is a national network of colleges and universities formed to promote the sharing of computer-based resources in higher education.   The operation of EDUNET is overseen by the Planning Council or Computing in Education and Research, which was formed in 1974.   The Planning Council is one of several special activities of EDUCOM - a non-profit organization established to   further cooperative efforts among institutions of higher learning.   EDUNET makes possible the   connection of any computer   terminal to   many computer centers across the country.   Among the statistical programs and packages accessible under EDUNET (January, 1978) are: APL, BMDP, DATAEDIT, IMSL, MANOVA,   MINITAB II, SPSS, TSP (at Stanford); BMD, DATATEXT, LIDA, TPL, TSP (at Yale);   FCST2***,   FCST3***,   FCST4***,   STATNOV***, STATPROB***, STATIS*** (at Dartmouth); MINITAB, STATJOB (at Wisconsin); SCSS (at Notre Dame); and many other packages at other universities such as Cornell, MIT,   Princeton, and Rice.   For information about available resources and services, documentation, charges and accounting, and other EDUNET matters, one may call the toll-free EDUNET Hotline (800) 257-9505, or write to:

    EDUNET Central
    P. O. Box 364
    Princeton, NJ 08540

    .... and current information items about EDUNET are ... to members (and to others upon request)   by the publications EDUNET News and EDUCOM Bulletin.

C.   The Symposium on the Interface of Computer Science and Statistics,   held annually since 1967, consists of a series of   workshops on   topics involving   statistical computing.   Papers presented at the workshops appear in the Proceedings of the Annual Symposium. Articles on the use of computers in statistical instruction has appeared regularly in recent Proceedings.

D.   The Association for Educational Data Systems (AEDS) is an organization which sponsors numerous computer related activities in education on a variety of topics, including, computer-assisted instruction, computer-managed instruction, computer-assisted guidance, computer-assisted testing, and so on.   Although most of its sponsored activities are not addressed specifically to statistical instruction, many of them do apply to computer   assisted instruction   in statistics.   Its   affiliated publications   (and annual subscription rate)   are: the AEDS Journal ($20),   the AEDS Monitor ($12), and the AEDS Bulletin ($5),   all published quarterly.   AEDS membership dues are $25 per year (student $10) which include subscriptions to the publications listed above.

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APPENDIX A

Available Statistical 3oftware Questionnaire

reproduced (with permission) from

Kohm, Robert F., Ryan, Thomas A. Jr., and
Velleman, Paul F. (1977), "Index of Publicly
Available Statistical Software," microfiche
in Proceedings of the Statistical Computing
Section, American Statistical Association.

------- AVAILABLE STATISTICAL SOFTWARE QUESTIONNAIRE -------

1.1   Complete name for the package or program?
_____

1.2   Short name or abbreviation for the program?

_____

1.3   Principal developer:
      Name _____
      Organization_____
      Department_____
      Address_____
      _____
      Telephone (____)_____-_____

1.4   Distributor if different from (1.3) above:
      Name _____
      Organization_____
      Department_____
      Address_____
      _____
      Telephone (____)_____-_____

1.5   Distributor of documentation if different from (1.4):
      Name _____
      Organization_____
      Department_____
      Address_____
      _____
      Telephone (____)_____-_____

1.6   Person responsible for preparation of this reply if different from (1.3).
      Name _____
      Organization_____
      Department_____
      Street_____
      City_____State_____Zip_____
      Telephone (____)_____-_____

1.7   Date of last program release and identification (e.g. Version 5.3)
      Date_____ Identification _____

1.8   Expected date of next release.
      Date_____

2.1   Does the program run in batch mode?

____ (a) Yes
____ (b) No   .

2.2   If your program is interactive, can it run as a (One or more answers)

____ (a) Fully interactive program with prompting questions.
____ (b) Fully interactive program with answers immediately
        available, but without prompting questions.
____ (c) As a control card checker   (i.e.
        essentially interactive checking of control
        cards for large batch-like analyses).

2.3   Program availability. (One or more replies)

____ (a) Not available for export to other computation centers?
____ (b) Passively distributed to other centers?
____ (c) Actively distributed to other centers?
____ (d) Available through time-sharing system?

2.4   If your program is available for export, how is it available?
       (One or more answers)
____ (a) Under a rental agreement. Cost_____

____ (b) For purchase.   Cost_____

____ (c) Through some computer association such as SHARE,
         VIM, CUBE, DECUS, CONDUIT, etc.

2.5   If your program is available for export, how is it transported?

____ (a) In a form which is compatible with one computer brand only.
____ (b) In some readily transportable language (e.g. ANSI Fortran).
____ (c) In separate versions for different computer brands.

2.6   If your program is available for export, approximately
       how many centers have received copies of your program?

       _____

2.7   Which of the following documentations does your program have?
       (One or more answers.)

____ (a) Primer intended for novice users or students with
          worked out examples.
____ (b) Reference manual.
____ (c) On line "HELP" selectively available "on request."
____ (d) Implementation or systems programmers guide.
____ (e) Other_____

2-1

2.8   Please check all compilers or interpreters required.

_____ (a) Fortran II
_____ (b) Fortran IV
          ANSI
_____   (c) Not verified
_____   (d) Verified on Bell Labs PFORT verifier
_____   (e) Verified on other verifier
_____ (f) Extended FORTRAN IV
_____ (g) COBOL
_____ (h) PL/1
_____ (i) Assembler
_____ (j) BASIC
_____ (k) APL
_____ (l) Algol 60
_____ (m) Algol 68
_____ (n) Other (please specify)_____
_____ (o) Special compiler (please specify)_____

2.9   On which computer makes has the program been
        successfully run.

Manufacturer   Model   Operating system (if important)
_____   _____   _____
_____   _____   _____
_____   _____   _____
_____   _____   _____
_____   _____   _____
_____   _____   _____
_____   _____   _____
_____   _____   _____

2.10   Is your program:

_____ (a) Under continuing development.
_____ (b) Being maintained only.
_____ (c) No longer being maintained.

2.11   Are local program modifications permitted?

_____ (a) Yes
_____ (b) No

2.12   Are local additions of capabilities permitted?

_____ (a) Yes
_____ (b) No

2.13   Has your program or package (or a technique unique to
        your program or package) ever been reviewed or described in a widely
        distributed journal or at a society meeting?

_____ (a) Yes (please list these on a separate sheet of paper)
_____ (b) No

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3.1   Rank your program's strengths with respect to the following
       applications   (1 for strongest, 2 for second strongest etc.).
       Do not rank inappropriate items.

_____ (a) The analysis of data.
_____ (b) Data manipulation, editing, table building, file handling.
_____ (c) Monte Carlo simulations
_____ (d) Teaching
_____ (e) Other _____

3.2   Which of the following would best describe your program?
       (Check only one.)

_____ (a) A stand alone main program.
_____ (b) A collection of separate main programs.
_____ (c) A special purpose statistical package or set of
           programs   (e.g. a linear models package).
_____ (d) An integrated general purpose system of statistical
           routines running under a monitor.
_____ (e) A set of subroutines or similar groupings of code.

3.3   What is the principal intended audience of your program
       in terms of statistical experience? (check only one)

_____ (a) Complete novices with little or no statistical background.
_____ (b) Naive users with one introductory survey course in
           statistics.
_____ (c) A user with moderate exposure to statistics coming
           from advanced courses in statistics or from periodic
           exposure to statistical methodology.
_____ (d) An advanced or sophisticated user possessing an
           extensive background in statistical method and theory.

3.4   How would you describe your principal intended audience
       in terms of computer experience? (check only one)

_____ (a) Novices with no previous exposure to data processing
           or computers.
_____ (b) Naive users who may have used the computer somewhat
           (in a course for example).
_____ (c) Users with moderate exposure to data processing
           techniques and familiarity with either some languages
           or with experience in using statistical packages.
_____ (d) Advanced or sophisticated users with programming
           experience and/or data processing expertise.

3.5   For what general fields is your package intended?
       (One or more answers)

_____ (a) Biological sciences
_____ (b) The social sciences
_____ (c) The engineering and physical sciences
_____ (d) Business and economics
_____ (e) General statistics
_____ (f) Other(s)_____

26

For the Questions 4.1 - 4.30 please circle the most appropriate answer using the following replies:

C Capability   The program or package has sufficient capabilities in this area to be considered as a feature.

L Limited   The program or package has some capabilities in this area, but they should be considered as limited.

D Documented   The .feature can be easily accomplished using the documentation supplied with the program, but is not a standard ("built-in") option.

F Feasible   The feature can be accomplished by users with some expertise in the area.

I Insufficient   The program or package has insufficient
or   "Blank"   capabilities in this area to be classified above.

P Planned   The program or package has either limited or no capability in this area, but program changes are planned to include this area in the "C" classification within one year.

O Obsolete   The program developer considers the program or this aspect of the program to be obsolete.

Programs may be listed in several categories. (For example, a nonparametric analysis of variance program would be listed both in Analysis of Variance and in Nonparametric Statistics.)

27

THE GENERAL CAPABILITIES AREAS

Data Management

C L D F I P O   4.1   File building and manipulation.

C L D F I P O   4.2   Variable and category labeling.

C L D F I P O   4.3   Data transformations (standardization, logs, arithmetic, etc.)

C L D F I P O   4.4   Matrix computations and manipulations.

C L D F I P O   4.5   Sorting and matching.

Editing

C L D F I P O   4.6   Case selection/exclusion.

C L D F I P O   4.7   Consistency checking (simple and compound logical checks)

C L D F I P O   4.8   Automatic error correction (consistency correction, imputation, etc.)

Computations

C L D F I P O   4.9   Simple data descriptions and statistics (means, std.dev, histograms, t-test, simple linear regression, one way ANOVA, bivariate plotting, etc.)

C L D F I P O   4.10   Multiple linear regression.

C L D F I P O   4.11   Analysis of Variance (balanced data and traditional designs).

C L D F I P O   4.12   Analysis of Covariance (balanced data and traditional designs).

C L D F I P O   4.13   Canonical correlation and principal component analysis.

C L D F I P O   4.14   Factor Analysis.

29

C L D F I P O   4.15   Multivariate analysis of variance and
                          discriminant analysis.

C L D F I P O   4.16   Non-linear regreasion.

C L D F I P O   4.17   Cluster analysis.

C L D F I P O   4.18   Simple analysis of multi-way tables (percentages, means,
                          std. dev., etc.)

C L D F I P O   4.19   Loglinear analysis of multiway tables.

C L D F I P O   4.20   Other analysis of categorical data.

C L D F I P O   4.21   Variance estimation for complex sample designs.

C L D F I P O   4.22   Time series analyses (spectrum analysis,
                          Box-Jenkins, forecasting, etc.)

C L D F I P O   4.23   Data smoothing and curve fitting
                          (exponential smoothing, splines, etc.)

C L D F I P O   4.24   Bayesian atatiatics.

C L D F I P O   4.25   Nonparametric statistics.

C L D F I P O   4.26   Random number generation and simulation.

Output

C L D F I P O   4.27   Table printing (multi-way tables: formatted,
                          category labela, etc.)

C L D F I P O   4.28   Graphica (veraatile displays of data and
                          intermediate reaulta on printer, teletype,
                          or apecial graphics hardware. Note: hiatograms
                          and plots in which uaera have no control over
                          the choice of variablea, acales, or plot aymbola,
                          are here defined to be "Limited" L.

C L D F I P O   4.29   Results of computations available immediately
                          (not in a subsequent run) aa input to other
                          procedures (e.g. residuala treated aa data to
                          other procedurea.)

C L D F I P O   4.30   Reaulta of computation and intermediate results
                          (e.g. QR decompoaitiona, correlation matricea, etc.)
                          output in machine-readable form (disk/tape/carda).

                                        ---- Thank you ----

2.J

APPENDIX B

Selected Questionnaire Replies

reproduced (with permission) from

Kohm, Robert F., Ryan, Thomas A. Jr., and
Velleman, Paul F. (1977), "Index of Publicly
Available Statistical Software," microfiche
in Proceedings of the Statistical Computing
Section, American Statistical Association.

3J

9. Simple data description
10. Multiple linear regression
11. Analysis of variance
12. Analysis of covariance
13. Canonical correlation & principal component
14. Factor analysis
15. Multivariate ANOVA & discriminant analysis
16. Nonlinear regression
17. Cluster analysis
18. Simple analysis of multi-way tables
19. Loglinear analysis of multi-way tables
20. Other analysis of categorical data
21. Variance estimation (complex sample designs)
22. Time series analysis
23. Data smoothing & curve fitting
24. Bayesian statistics
25. Nonparametric statistics
26. Random generation & Simulation

1. File manipulation
2. Variable labeling
3. Transformations
4. Matrix manipulations
5. Sorting & matching
6. Case selection/exclusion
7. Consistency checking of data
8. Auto error correction
27. Table printing (multi-way tables)
28. Graphics (versatile)
29. Reuse of computations in same run
30. Storage of computations
31. Run batch
32. Run interactively
33. Statistical level
34. Computing level

Column order (left to right): 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 | 1 2 3 4 5 6 7 8 | 27 28 29 30 31 32 33 34

Program	Capability codes (columns 26…9, 1…8, 27…34)	Abstract pages	I.D. #
MIT-SNAP	1 c l c c l l c l l l c c b a b	18 – 20	1977-001
AFSTAT	l c l c l l o l f o c c c c c c l c c l l l c c a o c	21 – 22	1977-002
AQD	1 1 c l c c l l c l f f c c c l c c c a d f l o c c a o b	23 – 25	1977-003
The IMSL Library	c c p c o l p c c c p o c o c c c o l l c c l l l l l c o c c	26 – 29	1977-004
TABSTAT	l c 1 c c f c c l c c l c c c f n a c c	30 – 31	1977-005
TSP/DATATRAN	c c c l o c l o l c c c c c c c c c c c a d a	32 – 34	1977-006
GLIM	1 c o f o c c c l c 1 l o c b c b	35 – 35	1977-007
RGSP	c p p c d o c f c p o c c c	36 – 36	1977-008
BMDP	o c f p c o o c c o c o o o o c o l o c l o o o c c o c a b	37 – 41	1977-009
BMD	f o) o c o o o o o c o l l c l f l l l l a b	42 – 44	1977-010
WRAPS	l 1 l c o l l o o c c o c c c	45 – 46	1977-011
LINWOOD and NONLINWOOD	c l l c c o o f f l o o b b	47 – 48	1977-012
SAS	f l f f l o f f o c c c c o c c o o o o c o o c o c o c o c b o a	49 – 51	1977-013
SAS (cont.)	l c o c a l o l o o f o l f l c c c o c o o c o c c o c n a o b	52 – 55	1977-014
CS	l c o c a l o l o o f o l f l c c c o c o o c o c c o c n a o b	56 – 57	1977-015
P-STAT	p l c p o o o o c c c c o o o o o o c c o c b b b	58 – 59	1977-016
Minitab II	l c p p p l l c c p l o l l o f p o c l b a a	60 – 61	1977-017
SPSS	l o p p p c p c o l l o o o o c l o c f c l c a a	62 – 63	1977-018
RUMMAGE	f l o f l o c l f l o f l l o c o b	64 – 65	1977-019
HPSTAT PACS	f o c o f o p l p p f o o c c c c o l o f o l f c o o c n a a b	66 – 67	1977-020
CADA Monitor	p p c p p f l c c o n c p p o c c o c p n a b a	68 – 68	1977-021
IMPRESS###	o c d d c d c d o f f d d d o o c c o d d o l c c d c n a a a	69 – 70	1977-022
SCSS	l l c c c o o c l c l c l l n a	71 – 71	1977-023
NTSYS	1 c l c o l l l o c c c l c c o b	72 – 72	1977-024
MATCAL	o o c c o c o c a c	73 – 73	1977-025
C-TAB II	o o c o b		

9. Simple data description --- 1. File manipulation
10. Multiple linear regression --- 2. Variable labeling
11. Analysis of variance --- 3. Transformations
12. Analysis of covariance --- 4. Matrix manipulations
13. Canonical correlation & principal component ------------------------------ 5. Sorting & matching
14. Factor analysis -- 6. Case selection/exclusion
15. Multivariate ANOVA & discriminant analysis ------------------------------- 7. Consistency checking of data
16. Nonlinear regression --- 8. Auto error correction
17. Cluster analysis
18. Simple analysis of multi-way tables -------------------------------------- 27. Table printing (multi-way tables)
19. Loglinear analysis of multi-way tables ----------------------------------- 28. Graphics (versatile)
20. Other analysis of categorical data --------------------------------------- 29. Reuse of computations in same run
21. Variance estimation (complex sample designs) ----------------------------- 30. Storage of computations
22. Time series analysis --- 31. Run batch
23. Data smoothing & curve fitting --- 32. Run interactively
24. Bayesian statistics -- 33. Statistical level
25. Nonparametric statistics --- 34. Computing level
26. Random generation & Simulation

Column headers (reading top-to-bottom of each pair):
26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9   1 2 3 4 5 6 7 8   27 28 29 30 31 32 33 34

```
                            2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1     1             2 2 2 3 3 3 3   Abstract
Program                     6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1 0 9 1 2 3 4 5 6 7 8 7 8 9 0 1 2 3 4   pages     I.D. #
EFAP, COFAMM, LISREL III            c        c  o          c        c  c      c b    74 -  75   1977-026
MULTIQUAL                             c                     c              c    c b    76 -  76   1977-027
MULTIVARIANCE                             c  c c c c c   c c    o    c  c c      c b    77 -  77   1977-028
LOGOG                                 c                      c        c          c b    78 -  78   1977-029
NORMOG                              c                        c        c        b b    79 -  79   1977-030
EXPAK                                              c  c       c        c        b b    80 -  80   1977-031
MOCA                                         c               c        c c      b b    81 -  81   1977-032
TSAR          c f f f f f f f c f f o f c d c c c c c c f l o o l c l        c a    82 -  82   1977-033
GENSTAT       d d    f  d c o c c p c f c c c c c l o c o d c d f c c c c    c b    83 -  83   1977-034
SOUPAC        l l    f l   f  c l l c o c l c c c o l c c d c d   l l c c    c b    84 -  85   1977-035
ROSEPACK      l                 c c     c c d     c o c      l c c    a c c    86 -  86   1977-036
STATII***     d d    c l  f f f f f        d c c c c c c   c c c        o c  n a b a    87 -  87   1977-037
LOGLIN                  o p               l   c l        c   c c      a c b    88 -  88   1977-038
Speakeasy     l l    c c f f f f f c c f c f c c c c p c c d l c   c c c c    a c a    89 -  90   1977-039
OMNITAB II    l l        p p p f f f f f f c c c l p c c c d d   p c c d    b a a    91 -  92   1977-040
AESTH                                      c d c d   c d d d c l d d n c b b    93 -  93   1977-041
DATAPAC       c p    p c   p p c p p p p p p p c c f f p c c     l c c f      c c    94 -  95   1977-042
DATAPLOT            f f   f    f f        f   l     p     o     c   n a c c    96 -  97   1977-043
PROBPAC                                                           n b c c    98 -  99   1977-044
ALSTAT        l l   c p             l l c c l l c     c c       c c l   b b a    100 - 101   1977-045
OSIRIS        l c      p c   c c d c c l c c c c c o c l c c d c l l p c    c c    102 - 105   1977-046
CENTS-AID                    c              l   c c     c     c      b c    106 - 106   1977-047
TSERIES             c                         c c   c    c l l   l   c      c b    107 - 107   1977-048
EXPLORII                                      c      c l l          c b    108 - 108   1977-049
STATJOB             c      l c f f c o c c c c c    c c l d c c c c    b c a    109 - 110   1977-050
```

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 9. Simple data description------------------------------------     ------------------------------ 1. File manipulation
10. Multiple linear-------------------------------------------- | |  ---------------------------- 2. Variable labeling
    regression                                                | | | |
11. Analysis of variance-------------------------------------- | | | | ------------------------- 3. Transformations
12. Analysis of covariance----------------------------------- | | | | | --------------------------- 4. Matrix manipulations
13. Canonical correlation---------------------------------- | | | | | | | --------------------------- 5. Sorting & matching
    & principal component                                 | | | | | | | | |
14. Factor analysis-------------------------------------- | | | | | | | | | | ------------------------- 6. Case selection/exclusion
15. Multivariate ANOVA---------------------------------- | | | | | | | | | | | ---------------------- 7. Consistency checking
    & discriminant analysis                             | | | | | | | | | | | | |                      of data
16. Nonlinear regression----------------------------- | | | | | | | | | | | | | ------------------ 8. Auto error correction
17. Cluster analysis------------------------------- | | | | | | | | | | | | | | | |
18. Simple analysis----------------------------- | | | | | | | | | | | | | | | | | --------------- 27. Table printing
    of multi-way tables                          | | | | | | | | | | | | | | | | | |                   (multi-way tables)
19. Loglinear analysis-------------------------- | | | | | | | | | | | | | | | | | | ------------- 28. Graphics (versatile)
    of multi-way tables                          | | | | | | | | | | | | | | | | | | |
20. Other analysis--------------------------- | | | | | | | | | | | | | | | | | | | | ------------ 29. Reuse of computations
    of categorical data                         | | | | | | | | | | | | | | | | | | | |               in same run
21. Variance estimation--------------------- | | | | | | | | | | | | | | | | | | | | | ----------- 30. Storage of computations
    (complex sample designs)                   | | | | | | | | | | | | | | | | | | | | |
22. Time series analysis----------------- | | | | | | | | | | | | | | | | | | | | | | --------- 31. Run batch
23. Data smoothing------------------- | | | | | | | | | | | | | | | | | | | | | | | | ------- 32. Run interactively
    & curve fitting                        | | | | | | | | | | | | | | | | | | | | | | |
24. Bayesian statistics------------- | | | | | | | | | | | | | | | | | | | | | | | | | ----- 33. Statistical level
25. Nonparametric statistics----- | | | | | | | | | | | | | | | | | | | | | | | | | | | --- 34. Computing level
26. Random generation--------- | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
    & Simulation              | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
```

Program	2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1 0 9 1 2 3 4 5 6 7 8	2 2 3 3 3 3 7 8 9 0 1 2 3 4	Abstract pages	I.D. #
TPL	c	o c c c a	111 - 111	1977-051
XTABS	c c c c c c c c	c c	112 - 113	1977-052
GRAFSTAT	c c c f d c c c p p c c c c f f c d f l c c f n a b a		114 - 114	1977-053
COCENTS	l c c d c b		115 - 115	1977-054
IDA	c f c c o f c l c c c c c c l c l c c c c c a c b		116 - 117	1977-055
Data-Text	c c l c c c c l c c c c c c c c c c l c c l c a a		118 - 119	1977-056

IDENTIFICATION	77-1	77-2	77-3	77-4	77-5	77-6	77-7	77-8	77-9	77-10	77-11	77-12	77-13	77-14	77-15	77-16	77-17	77-18	77-19	77-20
2.1 RUN BATCH	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	n	y	y	n	y	y	n	n	n	n	n	n	y	n	n	n	n	y	y	
2.2 INTERACTIVE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A FULL/PROMPTS		a	a		a	a								a				a	a	
B FULL/NOPROMPTS	b					b	b						b	b	b	b				
C CONTROL CHECKING					c					c							c			
2.3 AVAILABILITY	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NO EXPORT																				
B PASSIVE DISTRIB	b										b									
C ACTIVE DISTRIB		c	c	c		c	c	c	c	c		c	c	c	c	c	c	c	c	c
D VIA TIMESHARING		d	d		d	d					d		d		d		d			
2.4 HOW AVAILABLE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A RENTAL		a	a	a		a		a				a	a		a	a				
B ONE TIME COST	b		b				b		b	b								b	b	
C COMPUTER ASSOC										c										
2.5 TRANSPORT METHOD	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A ONE BRAND COMPUT	a		a								a		a	a				a		
B PORTABLE LANGUAG					b		b	b	b		b			b		b				
C DIFFERENT VERSIO	c		c			c		c	c		c			c		c			c	
2.6 NUMBER OF SITES	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A 0-10	a	a	a		a		a			a			a				a		
B 11-99								b						b		b		b	b
C 100 OR MORE				c		c			c	c		c	c			c	c		
2.7 DOCUMENTATION	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A PRIMER			a		a	a	a	a	a		a		a	a	a	a		a	
B REFERENCE	b	b	b	b		b		b	b	b	b	b	b	b	b	b	b	b	b	b
C ON LINE HELP			c		c	c	c		c	c			c						
D IMPLEMEN GUIDE								d	d	d		d	d		d	d	d		d
E OTHER											e		e					
2.8 COMPILER & INTER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A FORTRAN II																			
B FORTRAN IV	b	b		b		b	b	b	b	b		b		b	b	b		b	
ANSI																			
C NOT VERIFIED						c		c										
D PFORT																	d	
E OTHER VERIFIER				e			e							e		e		
F EXTENDED FORT IV		f		f														
G COBOL											g							
H PL/1	h												h					
I ASSEMBLER										i								
J BASIC																		j	j
K APL					k													
L ALGOL 60																		
M ALGOL 68																		
N OTHER																		
O SPECIAL COMPILER																		

IDENTIFICATION	77-1	77-2	77-3	77-4	77-5	77-6	77-7	77-8	77-9	77-10	77-11	77-12	77-13	77-14	77-15	77-16	77-17	77-18	77-19	77-20
2.10 DEVELOPMENT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A CONTINUING	I aI	aI	aI	aI	aI	aI	aI	aI	aI	aI	aI	I aI	aI	aI	aI	aI	aI	aI	aI	aI
B MAINTAINED ONLY	I	I	I	I	I	I	I	I	I	I bI	I	I	I	I	I	I	I	I	I	I
C NO LONGER MAINT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
2.11 LOCAL MODIFICATI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	In	In	In	Iy	Iy	Iy	Iy	Iy	Iy	Iy	In	Iy	Iy	Iy	In	Iy	Iy	Iy	Iy	I
2.12 LOCAL ADDITIONSI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	In	In	Iy	Iy	Iy	Iy	In	Iy	Iy	Iy	In	Iy	Iy	Iy	Iy	Iy	Iy	Iy	Iy	I
2.13 REVIEWED	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	In	In	Iy	Iy	Iy	Iy	Iy	Iy	Iy	Iy	Iy	Iy	Iy	Iy	Iy	Iy	Iy	Iy	Iy	I
3.1 RANK STRENGTHS	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A DATA ANALYSIS	I	1I	1I	1I	1I	2I	2I	1I	2I	1I	1I	3I	1I	1I	1I	2I	2I	1I	1I	2I
B MANIPULATION	I.	I	2I	2I	4I	1I	3I	3I	1I	3I	3I	2I	I	2I	2I	1I	4I	2I	3I	3I
C SIMULATION	I	I	4I	I	2I	I	4I	I	I	4I	I	I	I	I	I	3I	4I	I	I	I
D TEACHING	I	2I	3I	3I	3I	3I	5I	2I	I	2I	2I	I	2I	I	3I	1I	3I	2I	I	1I
E OTHER	I	I	I	I	I	1I	I	I	I	I	1I	I	I	3I	I	I	I	I	I	I
3.2 BEST PROG DESC	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A MAIN PROGRAM	I	I	aI	I	I	I	I	aI	I	I	I	I	I	I	I	I	I	I	I	I
B SEP MAIN PRCGRAMI	I	I	I	I	I	I	I	bI	I	bI	I	I	I	I	I	I	bI	I	I	I
C SPECIAL PURPOSE I	I	I	I	I	I	I	cI	I	I	I	I	I	I	I	I	cI	I	I	I	I
D INT. SYSTEM	I dI	dI	dI	I	dI	dI	I	I	dI	I	I	I	dI	dI	dI	dI	dI	I	I	dI
E SUBROUTINES	I	I	I	I eI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
3.3 STATISTICAL EXP I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NOVICE	I aI	I	I	I	I	I	I	I	aI	aI	I	I	I	I	aI	aI	aI	I	I
B NAIVE	I	I	I	I	I	I	I	I	bI	bI	I	bI	I	bI	I	I	I	bI	I
C MODERATE	I	I cI	cI	cI	cI	I	cI	cI	cI	cI	I	cI	cI	I	I	I	I	I	I
D ADVANCED	I	I	I	I	I	I	dI	I	dI	dI	I	I	I	I	I	I	I	I	I
3.4 COMPUTER EXPER. I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NOVICE	I	I	I	I	I	I aI	I	I	I	I	aI	I	aI	I	aI	aI	I	I	aI
B NAIVE	I bI	I	bI	I	I	I	bI	I	bI	bI	I	bI	I	bI	bI	I	I	bI	bI	I
C MODERATE	I	I cI	I	I cI	cI	I	I	cI	cI	cI	cI	I	I	I	I	I	I	I	I
D ADVANCED	I	I	I	I	I	I	I	I	dI	dI	I	I	I	I	I	I	I	I	I
3.5 GENERAL FIELDS I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A BIOLOGICAL SCIENI	I	I	I aI	I	I aI	aI	aI	aI	I aI	aI	I	I aI	I aI	aI	aI	I
B SOCIAL SCIENCES I	I	I bI	bI	I	I bI	bI	bI	bI	bI	bI	bI	bI	bI	bI	bI	bI	bI	bI	bI
C ENG & PHYSICAL I	I	I	I cI	I	I cI	cI	I	I	I cI	cI	I	I cI	I cI	cI	I
D BUSINESS & ECON I	I	I dI	dI	dI	dI	I dI	I	I dI	dI	dI	dI	dI	dI	I	I dI
E GEN. STATISTICS I	eI	eI	eI	eI	eI	I eI	eI	eI	eI	eI	eI	eI	eI	eI	eI	eI	eI	eI	eI
F OTHER	I fI	I	I	I fI	I	I	I	I	I	I	I fI	I	I	I	I	I fI

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IDENTIFICATION	77-21	77-22	77-23	77-24	77-25	77-26	77-27	77-28	77-29	77-30	77-31	77-32	77-33	77-34	77-35	77-36	77-37	77-38	77-39	77-40
2.1 RUN BATCH	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	y	y	n	n	n	n	n	n	n	n	n	n	n	n	y	y	y	y	n	
2.2 INTERACTIVE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A FULL/PROMPTS	a	a														a	a	a	a	
B FULL/NOPROMPTS	b																	b	b	
C CONTROL CHECKING																				
2.3 AVAILABILITY	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NO EXPORT																				
B PASSIVE DISTRIB	b		b										b		b			b		
C ACTIVE DISTRIB		c		c	c	c	c	c	c	c	c	c		c		c			c	c
D VIA TIMESHARING	d	d											d				d	d	d	
2.4 HOW AVAILABLE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A RENTAL		a				a								a						
B ONE TIME COST	b		b	b	b		b	b	b	b	b	b		b	b		b		b	
C COMPUTER ASSOC																				
2.5 TRANSPORT METHOD	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A ONE BRAND COMPUT	a	a	a										a		a					
B PORTABLE LANGUAG												b				b		b		b
C DIFFERENT VERSIO			c	c	c	c		c	c	c		c		c			c		
2.6 NUMBER OF SITES	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A 0 -10				a						a	a	a			a	a				
B 11-99	b	b			b	b	b		b				b	b	b			b		
C 100 OR MORE			c					c										c	c	
2.7 DOCUMENTATION	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A PRIMER	a	a					a				a	a		a	a	a	a			
B REFERENCE	b	b	b	b	b	b	b	b	b	b	b	b	b	b		b	b	b	b	
C ON LINE HELP	c	c		c	c	c	c		c						c		c	c		
D IMPLEMEN GUIDE	d	d	d									d	d	d			d	d	d	
E OTHER														e		e	e		e	e
2.8 COMPILER & INTER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A FORTRAN II																				
B FORTRAN IV		b	b							b	b	b		b	b					b
ANSI																				
C NOT VERIFIED		c														d				
D PFORT																d				
E OTHER VERIFIER																				
F EXTENDED FORT IV			f	f	f	f	f	f	f							f				
G COBOL																				
H PL/1																				
I ASSEMBLER																				
J BASIC	j																			
K APL																				
L ALGOL 60																				
M ALGOL 68																		n		
N OTHER																				
O SPECIAL COMPILER																	o			

IDENTIFICATION	77-21	77-22	77-23	77-24	77-25	77-26	77-27	77-28	77-29	77-30	77-31	77-32	77-33	77-34	77-35	77-36	77-37	77-38	77-39	77-40

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2.10 DEVELOPMENT   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
  A CONTINUING     I a I a I a I a I   I a I a I a I a I a I a I   I   I a I a I a I a I   I a I a I
  B MAINTAINED ONLY I   I   I   I   I b I   I   I   I   I   I   I   I b I b I   I   I   I   I   I   I
  C NO LONGER MAINT I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
--------------------------------------------------------------------------------------------------
2.11 LOCAL MODIFICATI I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
  YES OR NO       I y I y I y I y I y I n I y I y I y I y I y I y I y I y I n I y I y I n I y I n I y I
--------------------------------------------------------------------------------------------------
2.12 LOCAL ADDITIONS I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
  YES OR NO       I y I y I y I y I y I n I y I y I y I y I y I y I y I y I y I y I y I y I y I y I
--------------------------------------------------------------------------------------------------
2.13 REVIEWED     I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
  YES OR NO       I y I y I y I n I y I n I y I y I y I y I n I n I n I y I y I y I y I y I y I y I
--------------------------------------------------------------------------------------------------
3.1 RANK STRENGTHS I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
  A DATA ANALYSIS  I 2 I 3 I 1 I 1 I 1 I 1 I 1 I 1 I 1 I 1 I 1 I 1 I 1 I 1 I 1 I 1 I 1 I 1 I 1 I 1 I
  B MANIPULATION   I 3 I 1 I   I 3 I   I   I   I   I   I   I   I   I 2 I 2 I 2 I   I 3 I   I 2 I 3 I
  C SIMULATION     I   I   I   I   I   I   I   I   I   I   I   I   I   I 4 I   I   I 5 I   I   I 4 I
  D TEACHING       I 1 I 2 I   I 2 I 2 I 2 I 2 I 2 I 2 I 2 I 2 I   I 3 I 3 I 4 I 2 I 4 I 2 I 3 I 2 I
  E OTHER          I   I   I   I   I   I   I   I   I   I   I   I   I   I 3 I   I 2 I   I   I   I
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3.2 BEST PROG DESC I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
  A MAIN PROGRAM   I   I a I   I   I a I   I a I a I a I a I a I a I   I a I   I a I a I   I   I
  B SEP MAIN PROGRAM I   I b I   I   I   I b I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
  C SPECIAL PURPOSE I   I   I   I   I   I   I   I   I   I   I   I   I   I   I c I   I   I   I   I
  D INT. SYSTEM    I d I d I d I   I   I   I   I   I   I   I   I   I d I   I d I   I   I   I   I d I
  E SUBROUTINES    I   I   I   I e I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
--------------------------------------------------------------------------------------------------
3.3 STATISTICAL EXP I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
  A NOVICE         I a I   I   I a I   I   I   I   I   I   I   I   I   I   I   I   I   I   I a I
  B NAIVE          I   I   I   I   I   I   I   I   I   I b I b I b I   I   I   I b I   I   I b I
  C MODERATE       I   I   I c I   I c I c I c I c I c I   I   I   I c I c I c I c I   I c I c I c I
  D ADVANCED       I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I d I
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3.4 COMPUTER EXPER. I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
  A NOVICE         I a I   I   I   I   I   I a I a I a I a I a I   I a I   I   I a I a I a I a I
  B NAIVE          I   I   I b I   I b I b I b I b I b I b I b I b I   I b I b I   I b I   I
  C MODERATE       I   I   I c I   I   I   I   I   I   I   I   I   I   I c I   I   I   I   I
  D ADVANCED       I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
--------------------------------------------------------------------------------------------------
3.5 GENERAL FIELDS I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I   I
  A BIOLOGICAL SCIEN I   I a I a I a I a I a I a I a I   I a I a I   I a I a I a I   I a I a I   I
  B SOCIAL SCIENCES I b I   I b I b I b I b I b I b I   I b I b I   I b I b I b I   I b I b I   I
  C ENG & PHYSICAL  I   I   I   I c I c I c I c I c I   I   I   I   I c I   I c I c I c I c I c I
  D BUSINESS & ECON I   I   I d I d I d I d I d I   I d I d I   I d I d I d I d I d I   I
  E GEN. STATISTICS I   I   I e I e I e I e I e I   I   I   I e I e I e I   I e I   I e I e I
  F OTHER          I   I   I   I   I   I   I f I f I   I   I   I   I   I   I   I   I f I
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IDENTIFICATION	77-41	77-42	77-43	77-44	77-45	77-46	77-47	77-48	77-49	77-50	77-51	77-52	77-53	77-54	77-55	77-56
2.1 RUN BATCH	I	I	I	I	I	I	I	I	Y	I	I	I	I	I	I	I
YES OR NO	I	a I	n I	y I	n I	n I	n I	n I	n I	n I	n I	n I	y I	n I	y I	n I
2.2 INTERACTIVE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A FULL/PROMPTS	I	I	I	a I	I	I	I	I	I	I	I	I	I a I	I a I	I
B FULL/NOPROMPTS	I	I	I	b I	b I	b I	I	I	'I	I	b I	I	I	I	I	I
C CONTROL CHECKING	I	c I	I	I	I	I	I	I	I	I	c I	I	I	I	I	I
2.3 AVAILABILITY	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NO EXPORT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
B PASSIVE DISTRIB	I	b I	I	I	I	I	I	I	I	I	I	b I	I	I	I	I
C ACTIVE DISTRIB	I	I	c I	c I	c I	c I	c I	c I	c I	c I	c I	c I	I	c I	c I	c I	c I
D VIA TIMESHARING	I	I	I	I	I	d I	d I	I	d I	I	d I	I	d I	I	I
2.4 HOW AVAILABLE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A RENTAL	I	I	I	I	I	I	I	I	I	I	I	I a I	I	I a. I
B ONE TIME COST	I	b I	b I	b I	b I	b I	b I	b I	b I	b I	b I	b I	b I	b I	b I	b I	I
C COMPUTER ASSOC	I	I	I	I	I	I	I	I	I	I	I	c I	I	I	I
2.5 TRANSPORT METHOD	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A ONE BRAND COMPUT	I	I	I	I	I	a I	I	I	a I	a I	I	I	I	a I
B PORTABLE LANGUAG	b I	b I	b I	b I	b I	I	I	b I	b I	I	I	b I	b I	b I	b I	I
C DIFFERENT VERSIO	I	I	I	I	I	c I	I	I	I	I	I	I	c I	c I
2.6 NUMBER OF SITES	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A 0 -10	I	I	I	a I	a I	a I	I	I	a I	I	I	I a I	= I	I	I
B 11-99	I	b I	b I	I	I	I	I	b I	I	b I	b I	I	I	I	b I	b I
C 100 OR MORE	I	I	I	I	I	c I	I	I	I	c I	I	I	c I	I
2.7 DOCUMENTATION	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A PRIMER	I	I	a I	a I	a I	I	a I	I	I	I	I a I	I a I	I	I a I
B REFERENCE	I	I	b I	b I	I	b I	b I	b I	b I	b I	b I	b I	I	b I	I	b I
C ON LINE HELP	I	I	I	c I	c I	c I	I	I	I	I	I	c I	I	c I	I
D IMPLEMEN GUIDE	I	I	I	I	I	d I	d I	I	d I	I	I	d I	d I	I
E OTHER	I	e I	e I	I	I	e I	I	I	e I	I	I	I	e I	I
2.8 COMPILER & INTER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A FORTRAN II	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
B FORTRAN IV	I	I	I	I	I	b I	b I	I	b I	b I	I	b I	b I	I	b I	b I
ANSI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
C NOT VERIFIED	I	I	I	I	I	I	I	c I	c I	I	I	I	I	c I	I
D PFORT	I	I	d I	d I	d I	d I	I	I	I	I	I	I	I	I	I
E OTHER VERIFIER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
F EXTENDED FORT IV	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
G COBOL	I	I	I	I	I	I	R I	I	I	I	I	g I	I	I
H PL/1	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
I ASSEMBLER	I	I	I	I	I	i I	i I	I	I	I	i I	I	I	I	i I
J BASIC	I	j I	I	I	I	I	I	I	I	I	I	I	I	I	I
K APL	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
L ALGOL 60	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
M ALGOL 68	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
N OTHER	I	I	I	I	I	I	I	I	I	n I	n I	I	n I	I	I
O SPECIAL COMPILER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I

IDENTIFICATION	77-41	77-42	77-43	77-44	77-45	77-46	77-47	77-48	77-49	77-50	77-51	77-52	77-53	77-54	77-55	77-56
10 DEVELOPMENT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A CONTINUING	I a	I a	I a	I a	I a	I a	I a	I a	I	I	I a	I a	I a	I	I a	I a
B MAINTAINED ONLY	I	I	I	I	I	I	I	I b	I b	I b	I	I	I	I b	I	I
C NO LONGER MAINT	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
11 LOCAL MODIFICATI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I y	I y	I y	I y	I y	I y	I n	I y	I y	I y	I y	I y	I n	I y	I y	I
12 LOCAL ADDITIONSI	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I y	I y	I y	I y	I y	I y	I n	I y	I y	I y	I y	I y	I y	I y	I y	I
13 REVIEWED	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
YES OR NO	I y	I y	I n	I n	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I y	I
1 RANK STRENGTHS	I	I	I	I	I	I	I	I	I	I	I	I	I.	I	I	I
A DATA ANALYSIS	I 1	I 1	I 1	I 1	I	I 1	I 1	I	I 1	I	I 1	I 2	I 2	I 1	I 3	I 1	I 1
B MANIPULATION	I	I 3	I	I	I	I 2	I 1	I	I	I 2	I 1	I 1	I 2	I 1	I 4	I 2
C SIMULATION	I	I 2	I	I	I	I	I	I	I	I	I	I 3	I	I 5	I
D TEACHING	I 2	I 4	I 2	I	I	I	I	I 2	I 2	I	I	I 4	I 2	I 3	I 3
E OTHER	I	I	I 3	I 1	I	I	I	I	I 1	I 3	I	I	I	I 2	I
2 BEST PROG DESC	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A MAIN PROGRAM	I a	I	I	I	I	I	I a	I a	I	I a	I	I	I	I	I
B SEP MAIN PROGRAMI	I	I	I	I	I	I	I	I	I	I	I	I	I b	I	I
C SPECIAL PURPOSE	I	I	I a	I a	I	I	I	I	I	I	I	I a	I c	I	I
D INT. SYSTEM	I	I	I	I	I d	I d	I	I	I d	I	I	I	I	I d	I d
E SUBROUTINES	I	I e	I	I	I	I	I	I	I	I	I	I	I	I	I
3 STATISTICAL EXP	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I a	I
A NOVICE	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
B NAIVE	I b	I	I	I	I b	I	I b	I	I	I	I	I b	I	I	I
C MODERATE	I	I a	I a	I a	I	I a	I	I a	I a	I a	I a	I a	I	I a	I a	I
D ADVANCED	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
4 COMPUTER EXPER.	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A NOVICE	I	I	I	I	I a	I	I	I	I a	I a	I a	I a	I	I a	I
B NAIVE	I b	I	I	I	I	I	I b	I b	I	I	I	I b	I b	I
C MODERATE	I	I a	I a	I a	I	I a	I a	I	I	I a	I a	I	I	I
D ADVANCED	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
5 GENERAL FIELDS	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
A BIOLOGICAL SCIENI	a	I	I	I	I	I a	I a	I a	I a	I a	I a	I a	I a	I
B SOCIAL SCIENCES	I b	I	I	I	I	I b	I b	I b	I b	I b	I b	I b	I b	I b	I b
C ENG & PHYSICAL	I o	I	I	I	I o	I	I c	I o	I c	I	I	I	I
D BUSINESS & ECON	I d	I	I	I d	I d	I	I d	I d	I d	I d	I	I d	I d
E GEN. STATISTICS	I e	I e	I e	I e	I e	I e	I e	I e	I	I	I e
F OTHER	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I

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